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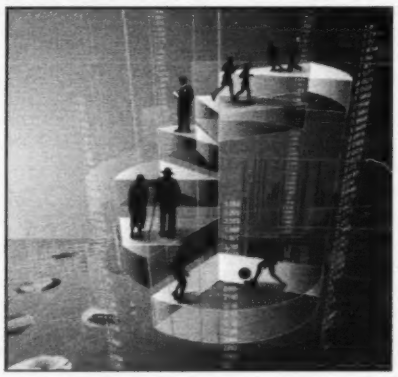

by Jungwee Park

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F too unreliable to be published
* significantly different from reference category ($p < 0.05$)

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Mortality from Alzheimer's disease in Canada: A multiple-cause-of-death analysis, 2004 to 2011

by Jungwee Park

Abstract

Using multiple-cause-of-death data, this study investigates mortality from Alzheimer's disease. From 2004 through 2011, Alzheimer's disease was coded as a cause of 80,868 deaths—more often the underlying than a contributing cause. The rate of Alzheimer's disease deaths was higher for women and older individuals than for men and younger people, and varied considerably by province/territory. Regardless of whether Alzheimer's disease was coded as the underlying or a contributing cause, on average, two other causes were also listed on the death certificate. When Alzheimer's disease was the underlying cause, cardiovascular diseases were most often listed as a contributing cause; when Alzheimer's disease was a contributing cause, cardiovascular diseases were most often listed as the underlying cause.

Keywords: Cardiovascular diseases, comorbidity, databases, death certificates, dementia, vital statistics

Alzheimer's disease, the most common form of dementia, is a progressive, degenerative and fatal brain disorder characterized by loss of memory and the ability to think and communicate, and by changes in mood and behaviour. The prevalence of Alzheimer's disease and other related dementias is expected to rise rapidly,[1,2] with one report projecting the number of cases in Canada to reach more than one million by 2038.[2] In 2011, it ranked seventh among the leading causes of death (ninth among men, sixth among women).[3]

Mortality from Alzheimer's disease may be underreported on death certificates.[4,5] For example, as the disease progresses, patients lose the ability to coordinate basic motor skills such as swallowing, walking, and bladder and bowel control. Difficulty swallowing can cause food to be inhaled, resulting in aspiration pneumonia; inability to walk can lead to bedsores; and incontinence can result in bladder infections, which are particularly difficult to manage because patients cannot understand and participate in their treatment.[6] Such secondary conditions, not Alzheimer's disease, may be recorded as the underlying cause of death. Therefore, examining Alzheimer's disease as the underlying cause may not fully capture the prevalence of deaths from the disease.

In accordance with international conventions, each death is classified by identifying a single underlying cause,[7,8] which is defined as the disease or injury that initiated the train of events leading directly to death or the circumstances of the accident or violence that produced the fatal injury.[9] However, chronic conditions such as Alzheimer's disease represent a number of coexisting conditions and are difficult to classify by a single cause.[9-12] These other conditions may include conditions recorded as the immediate cause of death, diseases intervening between the underlying and immediate cause, and contributory conditions outside the sequence of conditions leading to the death. In this analysis, causes recorded on the death certificate other than the underlying cause are called contributing causes.

To address the limitations of the single-cause approach, multiple-cause-of-death statistics (including underlying and contributing causes) are used. This approach provides a more complete assessment and better understanding of how a chronic condition is associated with death.

Aside from specific projects,[13-16] multiple-cause-of-death data have only recently become available in Canada.[7] Statistics Canada has created a Multiple-Cause-of-Death dataset that electronically captures underlying and contributing causes reported on death certificates (see *The data*). Based on these data, this study presents numbers and rates of Alzheimer's disease-related mortality (underlying cause of death and a contributing cause) and examines changes between 2004 and 2011. How Alzheimer's disease-related mortality is distributed by sex, age and province/territory is also examined. Finally, this study identifies common contributing causes when Alzheimer's disease is listed as the underlying cause of death, and common underlying causes when Alzheimer's disease is listed as a contributing cause.

Increase over time as underlying cause

The 80,868 Alzheimer's disease-related deaths that occurred from 2004 through 2011 made up 4.3% of all deaths during that period. Alzheimer's disease was the underlying cause of 48,525 (2.6%) deaths, and a contributing cause in 32,343 (1.7%) deaths. This difference indicates that Alzheimer's disease is more likely to be coded as the underlying cause than as a contributing cause—the ratio between the two was 0.67 (0.80 for men, 0.61 for women).

In 2008, changes in coding rules were implemented, and many deaths that would previously have been assigned to other causes were coded to Alzheimer's disease.[17] Because it is difficult to measure the contribution of this coding change to the increase in deaths from Alzheimer's disease from 2008 on, trends in mortality statistics for Alzheimer's disease should be interpreted with caution.

The crude mortality rate for Alzheimer's disease as the underlying cause rose between 2004 and 2011. For men, the rate increased from 10.1 to 11.5 per 100,000; for women, from 24.4 to 25.4 per 100,000 (Figure 1).

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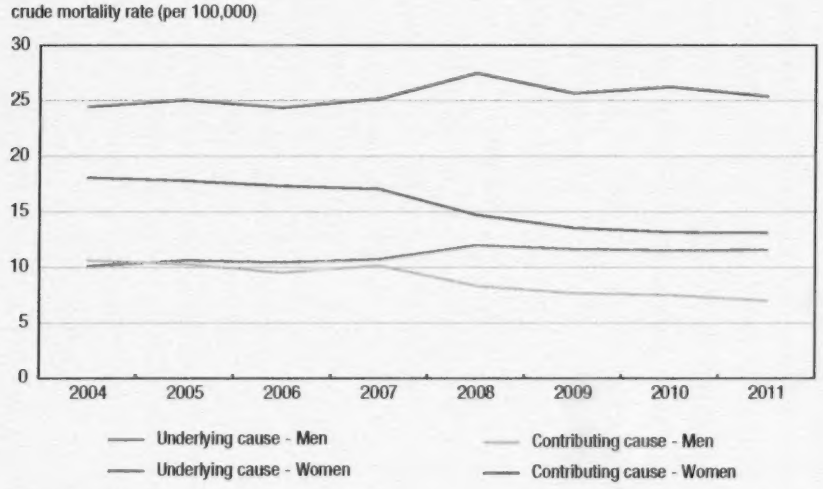
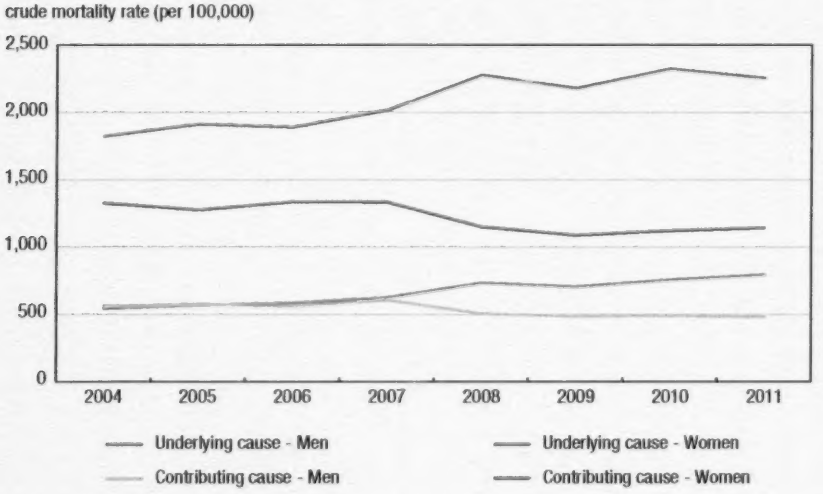
The mortality rate for Alzheimer's disease as a contributing cause fell starting in 2008 when the rate for Alzheimer's disease as the underlying cause began to increase, particularly among people aged 85 or older. Between 2004 and 2011, the rate with Alzheimer's disease as a contributing cause declined from 558.4 to 480.3 per 100,000 for men and from 1,321.5 to 1,137.3 per 100,000 for women in this age range. At the same time, the rate with Alzheimer's disease as the underlying cause rose from 540.7 to 793.3 per 100,000 among men and from 1,818.7 to 2,251.1 per 100,000 among women (Figure 2).

Figure 1
Crude mortality rate from Alzheimer's disease as underlying and contributing causes, by sex, 2004 to 2011, Canada



Source: Multiple-Cause-of-Death file, 2004 to 2011.

Figure 2
Crude mortality rate from Alzheimer's disease as underlying and contributing causes, by sex, population age 85 or older, 2004 to 2011, Canada



Source: Multiple-Cause-of-Death file, 2004 to 2011.

More common among women

Throughout the 2004-to-2011 period, women were more likely than men to die from Alzheimer's disease. Among women, 34,015 deaths (crude death rate 25.5 per 100,000) had Alzheimer's disease listed as the underlying cause, and 20,729 deaths (15.5 per 100,000) as a contributing cause. Among men, 14,510 deaths (crude death rate 11.1 per 100,000) were attributed to Alzheimer's disease as the underlying cause and 11,614 deaths (8.8 per 100,000) as a contributing cause (Table 1).

More likely at older ages

As expected, the rate of Alzheimer's disease deaths was higher among older individuals. For Alzheimer's disease as the underlying cause, the crude rate rose steadily from 0.8 per 100,000 at ages 45 to 64 to 679.8 per 100,000 at age 85 or older (Table 1). As a contributing cause, the rate increased from 0.4 per 100,000 at ages 45 to 64 to 433.4 per 100,000 at age 85 or older.

The average age at death from Alzheimer's disease, whether it was the underlying or a contributing cause, was about 86: 84 for men and 86 or 87 for women (Table 2). The percentage of deaths that were Alzheimer's disease-related rose from 1.4% among people who died at ages 65 to 74, to 4.9% at ages 75 to 84, and to 8.2% at age 85 or older (data not shown).

Provincial and territorial differences

The crude Alzheimer's disease-related mortality rate differed by province and territory. During the 2004-to-2011 period, in the provinces, the rate for Alzheimer's disease as either an underlying or contributing cause ranged from 19.4 per 100,000 in Alberta to 47.8 per 100,000 in Nova Scotia (Table 1). Mortality rates were much lower in the Northwest Territories and Yukon.

Differing age structures of provincial/territorial populations may be related to the rates of Alzheimer mortality. Low rates were found among provinces/territories with a small elderly population.

Table 1
Number and crude mortality rate (per 100,000) for Alzheimer's disease (underlying and contributing causes), by sex, age group, and province/territory, Canada, 2004 to 2011

	Underlying		Contributing			Total	
	Number of deaths	Crude rate	Number of deaths	Crude rate	Ratio (contributing to underlying)	Number of deaths	Crude rate
Both sexes	48,525	18.3	32,343	12.2	0.67	80,868	30.5
Men	14,510	11.1	11,614	8.8	0.80	26,124	19.9
Women	34,015	25.5	20,729	15.5	0.61	54,744	41.0
Age group (years)							
Younger than 45	x	x	x	x	x	17	0.0
45 to 64	564	0.8	267	0.4	0.47	831	1.1
65 to 74	2,616	13.6	1,640	8.5	0.63	4,256	22.1
75 to 84	15,545	125.6	11,431	92.3	0.74	26,976	217.9
85 or older	29,792	679.8	18,996	433.4	0.64	48,788	1113.2
Province/Territory							
Newfoundland	878	21.3	570	13.8	0.65	1,448	35.1
Prince Edward Island	208	18.6	128	11.5	0.62	336	30.1
Nova Scotia	2,080	27.7	1,513	20.1	0.73	3,593	47.8
New Brunswick	1,383	23.1	869	14.5	0.63	2,252	37.6
Quebec	16,005	25.8	9,071	14.6	0.57	25,076	40.5
Ontario	16,831	16.4	12,096	11.8	0.72	28,927	28.2
Manitoba	1,366	14.3	898	9.4	0.66	2,264	23.6
Saskatchewan	1,662	20.4	1,141	14.0	0.69	2,803	34.4
Alberta	3,004	10.6	2,493	8.8	0.83	5,497	19.4
British Columbia	5,082	14.7	3,553	10.3	0.70	8,635	25.0
Yukon	17	6.4	x	x	x	23	8.7
Northwest Territories	x	x	x	x	x	12	3.5
Nunavut	x	x	x	x	x	x	x

x supressed to meet confidentiality requirements of *Statistics Act*
Source: Multiple-Cause-of-Death file, 2004 to 2011.

Table 2
Characteristics of Alzheimer's disease deaths, by sex and underlying and contributing cause, Canada, 2004 to 2011

	Underlying cause			Contributing cause		
	Both sexes	Men	Women	Both sexes	Men	Women
Average age at death (years)	85.9	83.7	86.9	85.5	84.0	86.3
Number of other causes (%)						
0	18.5	15.1	20.0	16.0	14.8	16.7
1	29.9	29.8	29.9	27.8	27.2	28.1
2	23.7	24.8	23.2	24.5	24.4	24.5
3	14.1	15.2	13.7	15.2	15.8	14.9
4	7.3	8.1	7.0	8.3	9.1	7.8
5+	6.5	6.9	6.3	8.3	8.8	8.0
Average number of other contributing causes of death	1.9	2.0	1.8	2.1	2.1	2.0
Alzheimer's disease deaths out of all deaths (%)	2.6	1.5	3.7	1.7	1.2	2.2

Source: Multiple-Cause-of-Death file, 2004 to 2011.

Two other causes

Overall, 18.5% of Alzheimer's disease-related deaths were single-cause (Table 2). Among all deaths reported in the 2004-to-2011 period, the percentage with a single cause was 17%. When Alzheimer's disease was coded as an underlying cause, on average, 1.9 contributing causes were also listed on the death certificate, close to the average (2.2) for all deaths in that period (data not shown). When Alzheimer's disease was a contributing cause of death, on average, 2.1 other contributing causes were listed. This pattern was consistent across age groups.

Co-existing causes

When Alzheimer's disease was the underlying cause of death, cardiovascular diseases were most often listed as a contributing cause (46%), followed by respiratory infections (25%), and respiratory diseases (19%) (Table 3). Other frequently reported contributing causes were genitourinary diseases, endocrine disorders, diabetes mellitus, musculoskeletal diseases, and infections.

When Alzheimer's disease was a contributing cause, cardiovascular diseases were most often the underlying cause (41%), followed by malignant neoplasms (15%).

When Alzheimer's disease was the underlying cause, respiratory infections and respiratory diseases were more commonly listed as contributing causes for men than women (30% versus 23%, and 23% versus 17%, respectively).

Gender differences were also apparent when Alzheimer's disease was a contributing cause. For example, the percentage of cardiovascular diseases as the underlying cause was higher among women than among men (43% versus 37%). By contrast, the percentages were lower among women than among men for malignant neoplasms (14% versus 17%) and respiratory diseases (9% versus 12%).

Conclusion

Single-cause mortality data may underreport the contribution of chronic conditions such as Alzheimer's disease. Using multiple-cause-of-death data, this study found that from 2004 through 2011, a total of 80,868 deaths were Alzheimer's disease-related (48,525 as the underlying cause; 32,343 as a contributing cause). Alzheimer's disease mortality was significantly higher among women and older individuals. When Alzheimer's disease was coded as a cause of death (underlying or contributing), cardiovascular diseases were most often listed as either the underlying or a contributing cause.

Table 3
Number and distribution of Alzheimer's disease deaths (underlying and contributing), by other selected causes (contributing and underlying), Canada, 2004 to 2011

	Both sexes		Men		Women	
	Number	%	Number	%	Number	%
Underlying cause - Alzheimer's disease	48,525	...	14,510	...	34,015	...
Contributing cause						
Cardiovascular diseases	22,461	46.3	6,706	46.2	15,755	46.3
Respiratory infections	12,272	25.3	4,307	29.7	7,965	23.4
Respiratory diseases	9,194	19.0	3,293	22.7	5,901	17.4
Genitourinary diseases	6,386	13.2	2,077	14.3	4,309	12.7
Endocrine disorders	4,669	9.6	1,114	7.7	3,555	10.5
Diabetes mellitus	4,336	8.9	1,432	9.9	2,904	8.5
Mukuloscletal diseases	4,097	8.4	871	6.0	3,226	9.5
Infections	3,821	7.9	1,129	7.8	2,692	7.9
Contributing cause - Alzheimer's disease	32,343	...	11,614	...	20,729	...
Underlying cause						
Cardiovascular diseases	13,235	40.9	4,299	37.0	8,936	43.1
Malignant neoplasms	4,787	14.8	1,930	16.6	2,857	13.8
Respiratory diseases	3,173	9.8	1,419	12.2	1,754	8.5
Respiratory infections	2,051	6.3	810	7.0	1,241	6.0
Injuries	1,901	5.9	641	5.5	1,260	6.1
Digestive diseases	1,567	4.8	482	4.2	1,085	5.2
Diabetes mellitus	1,409	4.4	514	4.4	895	4.3
Skin diseases	1,192	3.7	463	4.0	729	3.5
Infections	1,085	3.4	350	3.0	735	3.5

... not applicable
Source: Multiple-Cause-of-Death file, 2004 to 2011.

The data

This analysis uses the Multiple-Cause-of-Death file, created by Statistics Canada. All causes entered on a death certificate are routinely coded, and those codes produce raw multiple-cause data.[8] To produce multiple-cause-of-death data, software (the Automated Classification of Medical Entities) assigns the underlying cause of death based on World Health Organization rules for selection and modification and causal relationships among diseases. Another system (TRANSAX) converts death codes to a form amenable to person-based analysis of multiple causes. This software eliminates redundant causes in death certificates and combines pairs of codes into a third code.[8]

Multiple-cause-of-death data for 2000 through 2011 were obtained from all provinces and territories—a total of 2,712,681 records. For earlier years, the data of certain provinces or territories were incomplete. To have complete information for all provinces and territories, this study used data for 2004 through 2011.

To produce multiple-cause-of death data at the national level for all provinces and territories, the multiple-cause information was merged with the Canadian Vital Statistics Death database maintained by Statistics Canada. The merge was based on the death registration number, province/territory, and year of occurrence. Because of mismatches between the two datasets, 0.6% of all deaths (0.4% of Alzheimer's disease-related deaths) were excluded from analysis.

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